





**INCIDENCE AND RISK FACTORS OF POST SPINAL HYPOTENSION AMONG OBSTETRIC PATIENTS UNDERGOING CESAREAN SECTION AT TIKUR ANBESSA SPECIALIZED HOSPITAL, ADDIS ABABA, ETHIOPIA; BY BIRUK ALEMU**

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## ACKNOWLEDGMENTS

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Praise and thanks to the Almighty who made it possible to achieve this day. My heartfelt gratitude goes to my advisors, Dr. Fetiya Alferid and Dr. Faiza Hulala for their unconditional guidance and constructive advice in various areas.

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### Abbreviations and acronyms

<b>APGAR</b>	Appearance, pulse, grimace ,activity, respiration
<b>ASA</b>	American Society of Anesthesiologists
<b>BMI</b>	Body Mass Index
<b>BP</b>	Blood Pressure
<b>CS</b>	Cesarean Section
<b>CSF</b>	Cerebro spinal fluid
<b>GA</b>	General anesthesia
<b>LA</b>	Local anesthetic
<b>MAP</b>	Mean arterial pressure
<b>RL</b>	Ringer lactate
<b>SAIH</b>	Spinal Anesthesia Induced Hypotension
<b>SPSS</b>	Statistical pachage for social sciences
<b>SVR</b>	Systemic vascular resistance
<b>TASH</b>	Tikur anbesa specialized hospital

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## ABSTRACT

### BACKGROUND

Post spinal hypotension is defined as a decline in mean arterial pressure (MAP) of more than 20% from baseline or systolic BP <90mmHG with in 20minutes of spinal anesthesia. Its prevalence ranges from 30.1-71.5%.

Hypotension may pose serious risks like loss of consciousness and cardiac arrest on mothers undergoing CS under spinal anesthesia.

**OBJECTIVE:** To assess the incidence and risk factors of post-spinal hypotension among patients undergoing cesarean section at Tikur Anbessa Specialized teaching Hospital, Addis Ababa, Ethiopia.

**METHODOLOGY:** An institution-based prospective cross-sectional study was conducted using 262 obstetric patients admitted to TASH from November 2024 to May 2024. Data was entered and cleaned and analyzed using SPSS version 26. Association between categorical variables was determined using correlation logistic regression. Odds ratio was calculated on variables to determine association through binary and multivariate logistic regression.

Those with P-value of 0.25 from binary logistic regression were brought to multivariable analysis and independent variables with P-Value less than 0.05 was regarded as a risk factor for

**Results:** Among 262 patients, 157 (60%) AOR 0.6353, 95% CI 0.0438-1.213 had post spinal hypotension following spinal anesthesia. Of which at 5% level of significance after multivariate binary logistic regression analysis, the odds of developing post spinal hypotension for gravidity <3 with P-value of 0.041 AOR 0.579, 95% CI (0.343-0.977), Supine patient position with P-value of 0.004 AOR 2.149 with 95% CI (1.271-3.633), No Use of spinal additive with P-value of 0.008 AOR 0.456 with 95% CI (0.255-0.814).

### Conclusion and recommendation

The incidence of hypotension to be 60% which shows that more than half of mothers receiving spinal anesthesia are developing hypotension, which is a significant figure and a big concern for safe modern anesthetic practice.

Although study on this particular area is sensitive and resource intensive, further multicenter studies are needed to better understand these factors, for provision of safe anesthesia in modern obstetric practice

## 1. Background

Cesarean section (CS) is a surgical operation in which a baby is delivered through an incision in the mother's abdominal wall. It is one of the most common surgical procedures globally (1)

Maternal mortality trend analysis showed an increasing trend in Ethiopia and CS is one of the lifesaving surgical procedures credited with lowering maternal and neonatal mortality and morbidity (2).

Cesarean anesthesia has grown in popularity as the number of cesarean births has increased. An acceptable method of delivering anesthesia for cesarean delivery is either localized (epidural or spinal) or general anesthesia (3). A spinal anesthetic is technically easier to place than an epidural anesthetic. It is more reliable in providing surgical anesthetic, with a failure rate of less than 1% (4).

Spinal anesthesia is a type of regional anesthesia that has been used for obstetric anesthesia since 1898 (5). Because of its simplicity and early start, as well as mother comfort and safety, regional anesthetic is now the most often used approach for CS (6). Using a spinal needle, local anesthetic drugs are injected into the subarachnoid space and adjacent nerves that feed the abdomen and uterus. This subarachnoid block is mostly administered between the L<sub>3</sub> and L<sub>4</sub> subarachnoid spaces, as well as the L<sub>4</sub> and L<sub>5</sub> subarachnoid spaces, and supplies at the T<sub>6</sub> to T<sub>10</sub> level (7). Many of the indicated patients underwent surgery under the subarachnoid block (1). It avoids newborn depression caused by general anesthesia, as well as higher appearance, pulse, grimace, activity, and respiration (APGAR) ratings and neurobehavioral exams (8).

The benefits of spinal anesthesia are its simplicity, rapid onset, low failure rate, low medication dose, and profound or dense sensory and motor block (9). Despite its simplicity and decreased maternal mortality risk when compared to general anesthetic, spinal anesthesia has been related to a variety of side effects, the most common of which is hypotension (6). After spinal anesthesia, hypotension is defined as a decline in mean arterial pressure (MAP) of more than 20% from baseline or systolic BP <90mmHG within 20 minutes of spinal anesthesia (10).

## 1.1 Statement of the Problem

Anesthesia-related maternal death is most common when general anesthesia is used for cesarean delivery. Other dangers associated with general anesthetic include failed endotracheal intubation, failure to ventilate, aspiration pneumonitis, tooth damage, postoperative nausea and vomiting, delayed breastfeeding, and baby sedation (11). The use of spinal anesthetic is preferred for the purpose. CSs are frequently performed under spinal anesthetic. It enables the mother to remain awake. It also reduces the risk of maternal aspiration pneumonitis and difficult intubation. It makes good postoperative pain management possible.

Spinal anesthesia, as seen by higher APGAR scores and neurobehavioral testing, avoids the newborn depression associated with general anesthesia (12). Aside from its benefits, spinal anesthesia has numerous negative effects. The most serious disadvantage of spinal anesthesia for mothers is hypotension. Maternal hypotension causes uteroplacental hypoperfusion and an abrupt drop in intervillous blood flow, which has the potential to cause fetal acidemia. Furthermore, cardiac arrest may occur (13).

## 1.2 Significance of the Study

In Ethiopia, the national CS rate ranges from 2 to 27% (14). Cesarean births are connected with a 35.7% postoperative morbidity rate. Higher rates of mortality and morbidity may be attributed not just to the surgical procedure but also to the anesthetic technique used (15). According to Shitemaw et al., (2020), the prevalence of hypotension was 64% among mothers who underwent CS under spinal anesthesia (16). This study indicates that hypotension occurs in more than half of the cases undergoing surgical delivery under spinal anesthesia, which is the most care-demanding circumstance. The author attempts to identify the incidence and risk factors of hypotension during spinal anesthesia for cesarean delivery to enhance treatment and patient care.

## 2. LITERATURE REVIEW

CS is a fetal delivery that involves an open abdominal incision (laparotomy) and a uterine incision (hysterotomy). The first reported CS took place in 1020 AD, and the process has progressed greatly since then (17). To perform a cesarean delivery, the surgeon must cut through all of the layers that separate him or her from the fetus. The *epidermis* is incised first, then the subcutaneous tissues. The fascia that covers the *rectus abdominis* muscles is the next layer. The anterior abdominal fascia is normally divided into two layers (18). The first is made up of aponeurosis from the external oblique rectus muscle, while the second is a fused layer made up of aponeuroses from the transverse abdominis and internal oblique muscles. The surgeon enters the abdominal cavity through the parietal peritoneum after separating the rectus muscles, which run from the cephalad to the caudal (19).

Analgesia should be administered to the patient before any procedure. Except in extreme cases, the anesthetic team will administer this. An anesthesiologist and/or a nurse anesthetist may be part of this team. Obstetric anesthesia is the responsibility of dedicated staff at some facilities. Anesthesia providers care for patients in all surgical suites, including the main operating room and labor floor, among others. In addition to providing analgesia, the anesthesiologist and/or anesthetist are responsible for managing the patient's airway as well as monitoring vital signs, surgical blood loss, and urine output (20). If extra drugs or blood products are required, or blood is collected for laboratory testing, the anesthesia crew is frequently in charge of these activities. Obstetric anesthesia is widely regarded as one of the more dangerous areas of anesthetic therapy. Changes in maternal physiology during pregnancy, as well as care for the mother and fetus, present an anesthesiologist with a unique task (21).

Local anesthetic (LA) injections into the spinal cerebrospinal fluid (CSF) give access to action locations within the spinal cord as well as peripheral nerve roots (22). Studies with somatosensory evoked potentials show little change in amplitudes or latencies after induction of thick spinal or epidural anesthesia, refuting the old concept of SA causing total conduction block (23). Local anesthetics have several potential activities within the spinal cord at various places. LAs, for example, can block sodium channels and limit the creation and propagation of electrical activity inside the dorsal and ventral horns (24). Other neuronal ion channels in the spinal cord,

such as calcium channels, are also critical for afferent and efferent neural activity. Spinal injection of N-type calcium channel blockers causes cell membrane hyperpolarization, resistance to electrical stimulation from nociceptive afferents, and severe analgesia (25).

LAs may have similar actions on neural calcium channels, which may contribute to the analgesic actions of central neuraxial administered LAs (26). Although spinal LAs can inhibit sodium channels and electrical conduction in spinal nerve roots, other processes may be at work as well. It is hypothesized that a significant portion of the sensory information supplied by peripheral nerves is carried via coding of electrical signals in after potentials and after oscillations (27).

Studies revealing a loss of sensory nerve function following incomplete LA blocking provide evidence for this idea. For example, despite the unhindered conduction of tiny fibers, skin temperature feeling can be lost (28). Furthermore, a surgical depth of epidural and spinal anesthesia can be obtained with only minor changes in somatosensory evoked potentials from the anesthetized area (29). Previous research has shown that sub-blocking concentrations of LA reduce naturally occurring after potentials and after-oscillations without appreciably impairing action potential conduction (30). Thus, disruption of electrical information coding by LAs may be a major mechanism for spinal nerve root block during SA.

Because it has a lower risk of maternal problems than general anesthesia (GA), SA is the chosen anesthetic regimen for cesarean delivery (31). Nonetheless, in these patients, hypotension is a common side effect of spinal anesthetic. Hypotension after spinal anesthesia is caused primarily by a decrease in systemic vascular resistance caused by vasodilation caused by preganglionic sympathetic fiber blocking (32). Because the placental vascular bed does not have autoregulation, prolonged maternal hypotension can be harmful to the fetus, causing decreased fetal Apgar scores, fetal acidosis, and hypoxia. Identification of risk variables related to SA-induced hypotension (SAIH) may aid in the prevention and early identification of patients most at risk, hence avoiding catastrophic effects in the mother and neonate (2).

Maternal and anesthesia-related risk factors are the two primary categories of risk factors for SAIH. Age, body mass index (BMI), gravidity, history of hypotension, baseline heart rate (HR), and height are maternal risk factors for SAIH during CS, while fluid preloading and sensory block height are anesthesia-related risk factors (33).

Advanced age has been frequently established as a predictor of SAIH in the literature. The cutoff point for developing hypotension after SA is maternal age of more than or equivalent to 35 years. Research has shown that older age groups have a larger tendency to have lower blood pressure (34). Hypotension and bradycardia are the most prevalent consequences in older individuals having neuraxial blocks due to changes in cardiac reserve and baroreceptor and sympathetic nervous system responses (35).

A higher BMI is another risk factor that is consistently linked to SAIH (36). SAIH was substantially linked with a BMI cut-off value of 30 kg/m<sup>2</sup>. Obese women had a greater 24-hour blood pressure (BP) profile than slim women, as well as a larger night/day ratio with a muted increase in systolic and diastolic nocturnal BP, indicating an overall increase in sympathetic nervous system activity. Because SA blocks these nerves, the decline in BP is even more pronounced. Another explanation for the higher prevalence of hypotension in obese parturients could be increased sympathetic blockage produced by gravid uterine compression of the subarachnoid space (37). Obese pregnant women are also more prone to cardiac contractility defects and conductivity of the cardiac electrical stimuli due to hyperinsulinemia and insulin resistance, which can result in fat deposits in the myocardium (38).

The number of pregnancies affects the incidence of SAIH, with pregnancies > 4 compared to 1 associated with a more than 5-fold and 7-fold increase in the chance of developing moderate and severe hypotension, respectively (39). The extent of the decrease in systemic vascular resistance (SVR) is greater in multiparous women than in nulliparous women, explaining the increased prevalence of hypotension associated with spinal anesthesia in multiparous women. Not only does baseline volume status influence hypotension with SA but so does baseline vascular tone. The peripheral vascular tone has been proven to be lower in term parturients, particularly multiparous women (40). Several studies have found that parturients with higher baseline heart rates (HRs) have a greater drop in BP after spinal anesthesia. Increased baseline HR is thought to imply increased sympathetic tone. Individuals with a high intrinsic sympathetic tone may be more likely to experience a significant reduction in BP as a result of spinal sympathectomy (41).

Hypotension was defined as a decrease of MAP of more than 30% within a 10-min interval, and relevance was defined as a therapeutic intervention with fluids or pressor within 20 min (42).

The maintenance of arterial BP is felt to be important to ensure adequate regional perfusion (43). SAIH is a common complication, especially in the elderly and patients undergoing CS. SAIH is induced by arterial and venous vasodilation produced by the sympathetic blockade, as well as a paradoxical activation of cardiac inhibitory receptors (44).

The sympathetic block caused by SA causes fast arterial and arteriolar vasodilation in the affected areas, which leads to an increase in sympathetic arterial vascular tone in the areas not affected by the block via a baroreflex. In general, compensating mechanisms are more successful in younger patients. The hemodynamic effects of SA include a sympathetic block of the venous reservoir, which causes blood to pool in the lowermost capacitance veins. When the amount of sensory block is greater than or equivalent to T<sub>6</sub>, this pooling in the hepato-splanchnic area might affect up to 20% of the circulating blood volume, which can be mobilized with vasopressors (44). Crystalloid preloading has been advocated for multiple decades as means of hypotension prevention after spinal anesthesia (45).

Crystalloid preloading reduced the incidence of hypotension from 71% to 55% in individuals receiving 20 mL/kg Ringer's Lactate (RL) solution (46). Although intravenous fluid preload became a standard feature of anesthetic therapy, it quickly became clear that it was ineffective. The American Society of Anesthesiologists (ASA) clinical practice guideline recommendation for spinal anesthesia for cesarean delivery states: "Although fluid preloading reduces the frequency of maternal hypotension, spinal anesthesia should not be delayed to administer a fixed volume of intravenous fluid." (47).

The short intra-vascular half-life of crystalloid solutions fluid is one reason why crystalloid preload may not properly prevent hypotension (48). Other experiments, with a few unconvincing exceptions, achieved the same conclusion, and as a result, most specialists no longer suggest crystalloid preloading. Several studies have indicated that spinal anesthesia-induced hypotension occurs often following sensory suppression at the level of >T<sub>5</sub>. This discovery is reinforced by the fact that nerve fibers controlling arterial and venous vasomotor tone emerge from T<sub>5</sub>-L<sub>1</sub> while cardiac accelerator fibers arise from T<sub>1</sub>-T<sub>4</sub> (49).

Under typical physiologic settings, animal studies have demonstrated that uteroplacental blood flow exceeds fetal oxygen demand, giving a safety buffer in terms of uterine flow variations

(50). As a result, the fetus's response to decreased uteroplacental perfusion is controversial. Despite the high prevalence of maternal hypotension during cesarean procedures, term newborns generally withstand this placental blood perfusion challenge without severe complications. According to one study, there is no difference in average first and fifth-minute APGAR scores between the general and spinal anesthetic groups. Short-term postnatal problems were not associated with hypotension lasting three, five, or ten minutes or more. The explanation could be owing to the short length of hypotension, or the placenta has its autoregulation in maintaining adequate perfusion at least for a short amount of time (51).

It is debatable if the patient's height affects the block level during spinal anesthesia. Several studies have found no statistically significant relationship between height and block level. Many studies do not modify the dose of local anesthetic based on height. A study discovered a substantial correlation between maternal height (155 cm) and PSAH. The spread of bupivacaine is unaffected by either maternal height or body weight, and no dose adjustment of bupivacaine for height is recommended (52)

Fakherpour et al., (2020) conducted prospective research on 511 mother-infant couples as part of an Iranian study in 2015 in which the mother underwent elective CS under SA. The information was gathered using a pre-set proforma with three sections for the parturient, anesthetic procedures, and a table for tracking maternal blood pressure. The prevalence of SAIH after elective CS was expected to be related to some maternal (such as age) and anesthesia-related risk variables (such as block height). Mild, moderate, and severe hypotension occurred 20%, 35%, and 40% of the time, respectively. Eventually, ten risk factors were found to be associated with hypotension, including age  $>35$  years, body mass index  $\geq 25$  kg/m<sup>2</sup>, 11-20 kg weight gain, gravidity  $\geq 4$ , history of hypotension, baseline systolic BP  $<120$  mmHg and baseline HR  $>100$  beats/min in maternal modeling, fluid preloading  $\geq 1000$  ml, adding sufentanil to bupivacaine and sensory block height  $>T_4$  in anesthesia-related modeling ( $p < 0.05$ ) (53).

From January 2019 to December 2020, Algarni et al., (2023) collected data on patients who underwent elective CS using SA from a tertiary hospital in Jeddah, Saudi Arabia. A retrospective cohort study approach was used for the research. Age, BMI, gestational age, comorbidities, the SA medication and dosage utilized, the location of the spinal puncture, and the patient's position during the spinal block were among the information gathered. At baseline, 5, 10, 15, and 20

minutes, the patient's BP, HR, and oxygen saturation levels were also recorded. There were 31.4%, 23.9%, and 30.1% incidences of mild, moderate, and severe hypotension, respectively. In addition, 15.1% of the patients had bradycardia, and 37.4% took longer than usual to recover. BMI and the SA dosage were two factors that were significantly associated with hypotension, with p-values of 0.008 and 0.009, respectively. The sole factor that was significantly associated with bradycardia (p-value = 0.043) was the location of the SA punctures, which had to be equivalent to or lower than L<sub>2</sub> (35).

Prospective observational research on 227 emergency patients who had CS with SA was carried out in 2019 by Chekol et al. (2021). Sociodemographic traits, anesthesia-related elements, maternal and surgical-related elements, and other aspects were taken into consideration as independent variables. In emergency CS, the incidence of hypotension was 56.8% (95% CI: (50.2, 63.4)). Baseline systolic blood pressure less than 120 mmHg, the absence of spinal additives, the duration of crystalloid load before 20 minutes, the speed of injection under 10 seconds, and the duration of crystalloid load before 20 minutes were all significantly associated with hypotension (AOR = 3.60, 95% CI; (1.26, 10.31), respectively (33).

On parturients who had elective CS with SA at TASH in 2019, Abebe Y, conducted an institution-based cross-sectional study. The outcome variable was PSAH, and 144 ASA I and ASA II mothers who were scheduled for elective CS under SA were included. The first five minutes were when PSAH most frequently occurred, with 103 (71.5%) women experiencing hypotension and 57 (55.3%) mothers experiencing severe hypotension. Significant associations with PSAH were reported for maternal age [p = 0.01, 95% CI (0.011, 0.565)], level of block height [p = 0.003, 95% CI (0.049, 0.547), and bupivacaine dose in ml [p = 0.046, 95% CI (0.277, 16.853)] (54).

At the Gandhi Memorial Hospital in Addis Ababa, Ethiopia, Shitemaw et al., (2020) conducted an institution-based cross-sectional study on 410 patients who satisfied the requirements of the ASA Physical Status II and on CS under SA in 2019. According to the report, 64% of mothers who received a CS following SA experienced hypotension. Newborn weight  $\geq 4$  kg [AOR = 5.373; 95%CI: (1.627–17.740)], baseline systolic blood pressure < 120 mmHg [AOR = 6.293; (95%CI: 2.999–13.204)], sensory block height >T<sub>6</sub> [AOR = 2.230; 95%CI: (1.329–3.741)], the time interval between spinal induction and skin incision > 6 minutes [AOR = 1.803; 95%CI:

(1.044–3.114)] and anesthetist experience [AOR = 5.033; 95%CI: (2.144–11.818)] were significantly associated with the outcome variable, PSAH (16).

### 3. Objectives

#### 3.1 General Objective

- To assess the incidence and risk factors of PSAH among obstetric CS patients at TASH in Addis Ababa, Ethiopia

#### 3.2 Specific Objectives

- To assess the incidence of PSAH among obstetric CS patients at TASH in Addis Ababa, Ethiopia
- To identify risk factors of PSAH among obstetric CS patients at TASH in Addis Ababa, Ethiopia

## 4. MATERIAL AND METHODS

### 4.1 Study Setting

#### COMPANY PROFILE

The Black Lion Specialized Hospital was established in 1961 by Emperor Haile Selassie I as “Prince Mekonnen Memorial Hospital” and got its current name in 1976. The hospital was built with funds from the entire Ethiopian people and has been providing services for all community. It is now reached treating over 500 thousand outpatients and more than 21 thousand inpatients annually.

The School of Medicine at Black Lion Specialized Hospital was established in 1972 under AAU and is one of the earliest medical schools in the country. The school has been providing quality medical education to students from Ethiopia and other African countries for more than five decades.

The College of Health Sciences (CHS) of AAU currently has 23 departments in four academic schools and one teaching hospital, and offers 8 undergraduate and 72 graduate programs. It is considered as a quality benchmark for similar programs running in other higher educational institutions in the country. It is known for publishing the largest number of scientific articles in AAU.

Gyn/obs ward is serving an approximate of a fifth of the beds and giving surgical and delivery services.

Anesthesiology critical care and pain medicine department is one of the departments in this hospital which gives care for patients who need both elective and emergency surgeries as well as patients who require ICU care additionally it also has pain services and out patient clinic for preoperative evaluation(54).

### 4.2 Study Design and Period

Institutional-based cross-sectional study was conducted at TASH from November 2023 to May 2024.

### 4.3 Source Population

All parturients undergoing Cesarean Section (CS) at TASH were the source population and

### 4.4 Study Population

All ASA II patients who received spinal anesthesia for both elective and emergency CS.

#### 4.5 INCLUSION CRITERIA

All parturient who met the requirements of Physical Status I and II as defined by the American Society of Anesthesiologists (ASA) and took spinal anesthesia for CS were included.

#### 4.6 EXCLUSION CRITERIA

Patients who;

Failed a spinal anesthesia procedure,

Those who had GA after failed spinal,

Those who had combined spinal epidural or epidural alone and

Mothers with uncontrolled comorbid conditions will be excluded.

#### 4.7 Sample Size Determination

The single population proportion formula was used to calculate the sample size. The calculation to determine the suitable sample size was based on a related study with  $p = 0.64$  (The prevalence of hypotension after spinal anesthesia at Gandhi Memorial Hospital in Ethiopia in 2019 was reported at 64%) (16). Finally, 281 sample sizes are obtained by applying a 95% level of significance, a 5% margin of error, and an additional 10% non-response rate.

$$n = \frac{(Z_{\alpha/2})^2 p(1-p)}{d^2}$$
$$n = \frac{(1.96)^2 (0.64)(1-0.64)}{(0.05)^2} = \frac{0.885}{0.0025} = 354.04 \sim 354$$

Since the sample size  $N < 10,000$ , where  $N$  is the population size (the number of CS patients that undergo spinal anesthesia at the maternity theatre per year) (i.e. 740), the final sample size calculation involved the finite population correction factor (FPC), which is

$$FPC = \sqrt{(N-n)/(N-1)}$$
$$FPC = \sqrt{(740-354)/(740-1)}$$
$$FPC = \sqrt{(386)/(739)}$$
$$FPC = \sqrt{0.52}$$

$$FPC = 0.72$$

$n^*$ , the new sample size is calculated by multiplying the FPC factor with the previous sample size,  $n$ , which is

$$n^* = n \times FPC$$

$$n^* = 354 \times 0.72$$

$$n^* = 255$$

Considering a 10% non-response rate, the final sample size is calculated to be

$$n^* = 255 + 25.5 \sim \mathbf{281}$$

#### 4.8 Sampling Techniques

A study participant was selected using a systematic random sampling technique with skip intervals from the daily operation for patients to undergo a CS.

#### 4.9 Operational Definitions

**Post-spinal hypotension:** A systolic BP of 90 or 100 mmHg or in relative terms as a percentage (20 percent from baseline).

#### 4.10 Study Variables

4.10.1 Dependent variable: Post-spinal hypotension (PSH)

4.10.2 Independent variables:

ASA Physical Status

Age

Height

Weight

Gravidity

BP

Heart rate

Local Anesthetic (LA) dose

Preload

Type of surgery (elective and emergency)

Anesthetist experience

Adjuvants used

Sensory block height.

#### 4.11 Data Collection

The data was collected using a pre-structured questionnaire adapted and modified from previous study tools.

Anesthesiology residents, and anesthetists assigned to the maternity OR all gathered data during the collection period from November-April 2024. A pretest was performed using 5% of the sample size before the actual data collection to assess the uniformity and understandability of the data collection instrument and make any required modifications. Data collectors received a half-day of instruction on handling surveys, making questions understandable, and interacting with study participants. To maintain the integrity of the data,

#### 5. Ethical Considerations

The College of Health Sciences at Addis Ababa University Ethical Review Committee provided the ethical approval. Addis Ababa University has provided TASH with a formal letter of support. The data collection format was not including patient-specific identifiers, and each piece of data was coded separately.

#### 6. Dissemination of Results

The results of the study will be submitted to the Department of Anesthesiology at Addis Ababa University's School of Medicine, and documentation will be distributed to all relevant organizations in the study area and the hospital where the study was conducted.

## 5. RESULTS

### 5.1 Socio-demographic data

A total of 262 cases who satisfy American society of anesthesiologists physical status II (ASA II) were included in this study. The age of the participants ranges from 18-42 years with mean age of  $29\pm 4.4$  years among which the majority of the study population (54.2%) is under 30 years and the remaining (45.8%) is above 30 years of age.

Regarding the weight of the cases, the majority were in the weight category  $>60\text{kg}$  (72%) and their height in the category of  $\leq 160\text{cm}$  (52.3%). 45% of the cases are overweight (BMI 25-30) and 11.8% were obese (BMI 30-35). No case is underweight.

Most of the mothers were gravida  $\geq 3$  (51.5%). 59% of Newborns weigh 2500-3500gm.

**Table 1 socio-demographic clinical data of the participants**

Variable	Category	Frequency	Percent %
Age; mean $\pm$ SD	8-42 years, ( $29\pm 4.4$ years)		
Age categories	$<30$ years	142	54.2
	$\geq 30$ years	120	45.8
Height	$\leq 160\text{cm}$	137	52.3
	$>160\text{cm}$	125	47.7
Weight	$\leq 60\text{kg}$	73	27.9
	$>60\text{kg}$	189	72.1
BMI	18.5-24.9	113	43.1
	25-29.9	118	45
	30-35	31	11.8
Baby weight	$<1500\text{gm}$	3	1.1

	1500-2500gm	22	8.4
	2500-3500gm	154	58.8
	3500-4000gm	70	26.7
	>4000gm	13	5

Table 2 Preoperative, intraoperative anesthesia provider drug related factors.

<b>Variable</b>	<b>Category</b>	<b>Frequency</b>	<b>Percent %</b>
<b>Fluid preload</b>	<b>Yes</b>	<b>222</b>	<b>84.7</b>
	<b>No</b>	<b>40</b>	<b>15.3</b>
<b>Amount of fluid</b>	<b>&gt;500ml</b>	<b>37</b>	<b>14.1</b>
	<b>500-1000ml</b>	<b>156</b>	<b>59.6</b>
	<b>&gt;1000ml</b>	<b>25</b>	<b>9.5</b>
<b>Pre SA SBP</b>	<b>&lt;120mmHG</b>	<b>105</b>	<b>40.1</b>
	<b>120-130mmHg</b>	<b>85</b>	<b>32.4</b>
	<b>&gt;/=130mmHg</b>	<b>72</b>	<b>27.5</b>
<b>Pre SA HR</b>	<b>&lt;90</b>	<b>136</b>	<b>51.9</b>
	<b>&gt;/=90</b>	<b>126</b>	<b>48.1</b>
<b>Prophylactic vasopressor used</b>	<b>Yes</b>	<b>19</b>	<b>7.3</b>

	<b>No</b>	<b>243</b>	<b>92.7</b>
<b>Type of bupivacaine used</b>	<b>Marcaine</b>	<b>93</b>	<b>35.5</b>
	<b>Sakane</b>	<b>103</b>	<b>39.3</b>
	<b>Bupidex</b>	<b>66</b>	<b>25.2</b>
<b>Dose of bupivacaine used</b>	<b>10mg</b>	<b>127</b>	<b>48.5</b>
	<b>12.5mg</b>	<b>115</b>	<b>43.9</b>
	<b>15mg</b>	<b>16</b>	<b>6.1</b>
<b>Additive used</b>	<b>Yes</b>	<b>85</b>	<b>32.4</b>
	<b>No</b>	<b>177</b>	<b>67.6</b>
Patient position after SA	<b>Supine</b>	<b>121</b>	<b>46.2</b>
	<b>Supine with left tilt</b>	<b>141</b>	<b>53.8</b>
Experience of the anesthesia provider	<b>Y1</b>	<b>50</b>	<b>19.1</b>
	<b>Y2</b>	<b>44</b>	<b>16.8</b>
	<b>Y3</b>	<b>38</b>	<b>14.5</b>
	<b>Senior anesthesiologist</b>	<b>1</b>	
	<b>Anesthetist</b>	<b>129</b>	<b>49.2</b>

The above data shows fluid preload was given for 222 (84.7%) of the cases and the most commonly used amount was 500-100ml (59.1%) normal saline given for all the preload groups. prophylactic vasopressor was given for only 19 (7.9%) of the cases.

Pre spinal anesthesia hemodynamics wise, most have pre anesthesia SBP <120mmHg (40.1%) of the cases and HR <90 (51.9%).

The most commonly used local anesthetic is hyperbaric bupivacaine in all of the cases, with the brand name of sakane in 103 ( 39.3%) of the cases and next commonly used one is Marcaine 93 (35.5%) of the cases.10mg bupivacaine is the most commonly administered dose (48.5%) with morphine as an additive which is used in 85 of the cases (32.2%).

After spinal anesthesia was given the majority of the patients; 141 (53.8%), were put in left lateral position.

Anesthetists are taking care for 129 (49.2%) of the cases for which they are responsible for the majority of the emergency cases which account 148 (56.5%) of the total sample size and the next commonly attending anesthesia providers are year 1 residents.

In 204 (77.9%) of the cases T4-T6 sensory block level was achieved and there was episode of hypotension in 157 (60%) among which the majority are in the moderate range of hypotension.

## 5.2 Risk factors associated with post spinal hypotension

The univariate and bivariate logistic regression analysis was performed on each independent variable with relation to post spinal hypotension. Finally, variables having P- value  $\leq 0.25$  in at least one of the separate bivariate logistic regressions were selected, then these are included in the multivariate logistic regression analysis accordingly age of patient, height of patient, gravidity, pre op BP, Type of the surgery, Additive used, patient position after spinal anesthesia, experience of anesthesia provider, sensory block level and Total duration of surgery were included in the multivariate logistic regression (Table 3)

**Table 3 Multivariate logistic regression analysis showing factors associated with hypotension among pregnant mothers who undergone C/S under spinal anesthesia.**

Variable	Category	Episode of hypotention		COR	95%CI
		YES, No.(%)	NO, No.(%)		
Age(years)	<30	76(53.5%)	66(46.5%)	1.697	0.166-17.327
	$\geq 30$	81(67.5%)	39(32.5%)	1.000	
Height (cm)	$\leq 160$	72(52.5%)	65(47.5%)	0.459	0.045-4.702
	>160	85(68%)	40(32%)	1.000	
Gravidity	<3	67(52.7%)	60(47.5%)	<b>0.616</b>	<b>0.345-1.100</b>
	$\geq 3$	90(66.7%)	45(33.3%)	1.000	
Baseline SBP	<120	67(63.8%)	38(36.2%)	0.817	0.420-1.588
	120-130	55(64.7%)	30(35.3%)	0.645	0.564-0.906
	$\geq 130$	35(48%)	37(52%)	1.000	
Surgery type	Emergency	80(54%)	68(46%)	0.629	0.212-1.870
	Elective	77(67.5%)	37(32.5%)	1.000	
Additive used	Yes	62(73%)	23(27%)	1.000	<b>0.230-1.133</b>
	No	95(53.7%)	82(46.3%)	<b>0.511</b>	

Patient position after SA	Supine	83(68.6%)	38(31.4%)	<b>2.270</b>	<b>1.304-3.951</b>
	Supine with left tilt	74(52.5%)	67(41.5%)	1.000	
Experience of anesthesia provider	Y1	30(60%)	20(40%)	0.693	0.271-1.767
	Y2	30(68%)	14(32%)	0.472	0.159-1.395
	Y3	27(63%)	11(37%)	0.446	0.117-1.697
	MSC Anesthetist	69(53.5%)	60(46.5%)	1.000	
Sensory block level	T4-T6	121(60%)	83(40%)	7.056	0.818-60.849
	T6-T8	28(57%)	21(43%)	1.000	

Then, step by step multivariate logistic regression was done to identify independent variables which have P-value <0.05 using backward elimination technique.

**Table 4 multivariate logistic regression using backward elimination**

Variable	Category	P-value	COR	AOR	95%CI
Gravidity	<3	0.041	0.616	0.579	0.343-0.977
	>3	1.000			
Additive use	No	0.008	0.511	0.456	0.255-0.814
	Yes	1.000			
Patient position	Supine	0.004	2.270	2.149	1.271-3.633
	Lateral	1.000			

Finally, gravidity <3 with P-value of 0.041 AOR 0.579, 95% CI (0.343-0.977), Supine patient position with P-value of 0.004 AOR 2.149 with 95% CI (1.271-3.633), No Use of spinal additive

with P-value of 0.008 AOR 0.456 with 95% CI (0.255-0.814) are independent variables which are identified as strong risk factors for the incidence of post spinal anesthesia induced maternal hypotension during both emergency and elective CS.

## 6. DISCUSSION

Hypotension was defined as absolute drop in systolic blood pressure or percentage of drop in mean arterial blood pressure in different literatures. Systolic blood pressure less than 100mmHg was used to define hypotension by Aya et al and Mercier (1,8) and systolic blood pressure less than 90 mmHg was used as cutoff to define hypotension by three different authors (2,4,12). Due to this variability in using cut off number to define hypotension, a percentage drop in MAP was used in this study to define hypotension despite its clinical application may not be as practical as the use of cut off number. For this study, drop in MAP more than 20% or SBP<90mmHg within 20minutes of spinal anesthesia was used to define hypotension (2,4,12).

In our study, the overall incidence of hypotension among mothers undergone a cesarean section with spinal anesthesia is 60%. Previous studies have been examined the incidence of hypotension after spinal anesthesia for C/S revealing different results. A prior study in Ethiopia was observed hypotension incidence of 64% after spinal anesthesia. Other studies in different parts of the world; have reported 65.1%, 76.7%, 80%, and 56.5% incidence of hypotension. The possible reason for the different incidence might be due to different methods of measurement, the operational definition of hypotension, and clinical setup [1, 6–10].

In our study, the incidence of post spinal hypotension is found to be 60% which is slightly showing difference from previously done study in Ghandi memorial hospital (64%) and comparable with most studies done in different parts of the world, despite the studies were done using different methodologies.

This study shows strong association between hypotension and gravidity  $\geq 3$  with P-value of 0.041 AOR 0.579, 95% CI (0.343-0.977), Supine patient position with P-value of 0.004 AOR 2.149 with 95% CI (1.271-3.633), Use of spinal additive with P-value of 0.008 AOR 0.456 with 95% CI (0.255-0.814)

According to Fakherpour et al., (2020) as part of an Iranian study in 2015 in which mothers underwent CS under SA. The prevalence of SAIH after CS was expected to be related to some maternal (such as age) and anesthesia-related risk variables (such as block height). Mild, moderate, and severe hypotension occurred 20%, 35%, and 40% of the time, respectively.

Eventually, they ten risk factors to be associated with hypotension, including age >35 years, body mass index  $\geq 25 \text{ kg/m}^2$ , 11-20 kg weight gain, gravidity  $\geq 4$ , history of hypotension, baseline systolic BP <120 mmHg and baseline HR >100 beats/min in maternal modeling, fluid preloading  $\geq 1000 \text{ ml}$ , adding sufentanil to bupivacaine and sensory block height >T<sub>4</sub> in anesthesia-related modeling (p < 0.05) (53).

These are relatively comparable results with our study interns of some independent variables which were included by the researchers.

Gravidity and maternal base line BP are similarly risk factors in our study, but others like BMI, fluid preloading base line heart rate and the like are not shown to be strong risk factors.

A similar study done at GMH at Addis ababa, Ethiopia done by shitemaw et al, shown that the overall incidence to be 64% which is nearly similar to the result of our study.

The risk factors strongly associated with the incidence of post spinal hypotention they found were, Newborn weight  $\geq 4 \text{ kg}$ , baseline systolic blood pressure

< 120mmHg, Sensory block height >T<sub>6</sub>, the time interval between spinal induction and skin incision > 6minutes and anesthetist experience. Despite this, the two studies have different risk factors with strong association with dependent variable.

## 7. STRENGTH AND LIMITATION

### 7.1 Strengths of the study

The study tried to identify women at risk of developing hypotension which can help anesthesia providers to work on prevention of hypotension from occurring.

The study tried to address areas to improve to decrease the incidence of hypotension.

### 7.2 Limitations of the study

Limited provision of resources

Busy theaters during the data collection period

Data collectors turn over was high

Inability completely to include those cases done during duty hours by the anesthetists.

## 8. CONCLUSION AND RECOMMENDATION

### 8.1 Conclusion

This study, aimed to investigate incidence and associated risk factors, has found the incidence of hypotension to be 60% which shows that more than half of mothers receiving spinal anesthesia are developing hypotension, which is a significant figure and a big concern for safe modern anesthetic practice. This is associated with maternal gravidity low base line SBP, and supine position after delivering the Spinal anesthetic.

Although study on this particular area is sensitive and resource intensive, further multicenter studies are needed to better understand these factors, for provision of safe anesthesia in modern obstetric practice.

### 8.2 Recommendation

National or hospital-based protocols should be prepared as well as Careful patient selection evaluation and pre anesthetic optimization is recommended in our practice of anesthesia for obstetric patients.

We have to be more cautious not to augment the hypotension induced by the sympathectomy effect of local anesthetic with full supine patient position and if possible, reduce the dose of local anesthetic and use additive as standard practice.

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## 10. APPENDICES

### 10.1 APPENDIX A: ASA Physical Status Classification System

<b>ASA I</b>	A normal healthy patient	Healthy, non-smoking, no or minimal alcohol use	Healthy (no acute or chronic disease), normal BMI percentile for age	
<b>ASA II</b>	A patient with mild systemic disease	Mild diseases only without substantive functional limitations. Current smoker, social alcohol drinker, pregnancy, obesity (30<BMI<40), well-controlled DM/HTN, mild lung disease	Asymptomatic congenital cardiac disease, well controlled dysrhythmias, asthma without exacerbation, well controlled epilepsy, non-insulin dependent diabetes mellitus, abnormal BMI percentile for age, mild/moderate OSA, oncologic state in remission, autism with mild limitations	Normal pregnancy*, well controlled gestational HTN, controlled preeclampsia without severe features, diet-controlled gestational DM.
<b>ASA III</b>	A patient with severe systemic disease	Substantive functional limitations; One or more moderate to severe diseases. Poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, history (>3 months) of MI, CVA, TIA, or CAD/stents.	Uncorrected stable congenital cardiac abnormality, asthma with exacerbation, poorly controlled epilepsy, insulin dependent diabetes mellitus, morbid obesity, malnutrition, severe OSA, oncologic state, renal failure, muscular dystrophy, cystic fibrosis, history of organ transplantation, brain/spinal cord malformation, symptomatic hydrocephalus, premature infant PCA <60 weeks, autism with severe limitations, metabolic disease, difficult airway, long term parenteral nutrition. Full term infants <6 weeks of age.	Preeclampsia with severe features, gestational DM with complications or high insulin requirements, a thrombophilic disease requiring anticoagulation.
<b>ASA IV</b>	A patient with severe systemic disease that is a constant threat to life	Recent (<3 months) MI, CVA, TIA or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, shock, sepsis, DIC, ARD or ESRD not undergoing regularly scheduled dialysis	Symptomatic congenital cardiac abnormality, congestive heart failure, active sequelae of prematurity, acute hypoxic-ischemic encephalopathy, shock, sepsis, disseminated intravascular coagulation, automatic implantable cardioverter-defibrillator, ventilator dependence, endocrinopathy, severe trauma, severe respiratory distress, advanced oncologic state,	Preeclampsia with severe features complicated by HELLP or other adverse event, peripartum cardiomyopathy with EF <40, uncorrected/decompensated heart disease, acquired or congenital.
<b>ASA V</b>	A moribund patient who is not expected to survive without the operation	Ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology or multiple organ/system dysfunction	Massive trauma, intracranial hemorrhage with mass effect, patient requiring ECMO, respiratory failure or arrest, malignant hypertension, decompensated congestive heart failure, hepatic encephalopathy, ischemic bowel or multiple organ/system dysfunction.	Uterine rupture.
<b>ASA VI</b>	A declared brain-dead patient whose organs are being removed for donor purposes			

### 10.2 APPENDIX B: SAIH - Definition and Severity

SAIH is defined in absolute terms as a systolic blood pressure of 90 or 100 mmHg or in relative terms as a percentage (20 percent from baseline).

Moderate: a drop of MAP by >20%

Severe: a drop of MAP by >30%

### 10.3. Appendix C: Consent explanation

I Dr. Biruk Alemu, a final year anesthesiology resident at Addis Ababa University. I am the principal investigator of a study, of which you are about to be explained to you in full details before agreeing to participate in the study.

#### Study

The study aims to assess the incidence and risk factors for hypotension during spinal Anesthesia for cesarean section at Tikuranbessa hospital. Spinal anesthesia is very safe, fast and very reliable type of anesthesia but has side effect like hypotension. Hypotension is drop in blood pressure which commonly occurs after spinal anesthesia which is going to be given to you. Since hypotension is common side effect of hypotension this study tries to assess how common it is at our hospital and helps to improve the interventions used to decrease the severity of hypotension.

#### Confidentiality

Participant's identity was protected. Only codes will be used as reference.

Thank you.

### 10.4 Appendix D Questioner

#### *Part I: Sociodemographic Information*

SN	Variable	Category
1.	Age (Years)	
2.	Weight (Kg)	

<b>3.</b>	Height (cm)		
<b>4.</b>	BMI (Kg/m <sup>2</sup> )		18.5 – 24.9
			25 – 29.9
			≥ 30
<b>5.</b>	Baby Weight (Kg)		
<b>6.</b>	Type of Surgery		Elective
			Emergency
<b>7.</b>	Gravidity		I
			II
			III
<b>8.</b>	ASA Classification		I
			II
			III
			IV
<b>9.</b>	Preoperative Hemodynamic Status	BP (mmHg)	< 120
			120 – 130
			≥ 130
	HR (bpm)	< 90	
		≥ 90	
<b>10.</b>	Amount of crystalloids preloaded (ml)		500
			500 – 1000
			1000 – 1500
			1500 – 2000

			> 2000
<b>11.</b>	Type of fluid		
<b>12.</b>	Prophylactic vasopressor used	Yes	
		No	
<b>13.</b>	If yes to Q13	Type	
		Dose	
<b>14.</b>	Bupivacaine Use	Type	
		Dose	
<b>15.</b>	Adjuvant use	Yes	
		No	
<b>16.</b>	If yes to Q16	Type	
		Dose	
<b>17.</b>	Size of the needle		
<b>18.</b>	Position of the patient after the SA	Supine	
		Lateral	
		Others	
<b>19.</b>	Experience of the anesthetist	Year I Resident	
		Year II Resident	
		Year III Resident	
		B.Sc. Student	
		Anesthetist	
<b>20.</b>	Sensory block height	> T <sub>4</sub>	
		T <sub>4</sub> - T <sub>6</sub>	

		< T <sub>6</sub>		
<b>21.</b>	The time interval between SA and skin incision			
<b>22.</b>	Duration of the surgery (minutes)	< 30		
		> 30		
<b>23.</b>	Was there an episode of hypotension?	Yes		
		No		
<b>24.</b>	If yes, what was the lowest BP recorded (mmHg)	100 - 90		
		90 - 80		
		< 80		
<b>25.</b>	Onset time of the hypotension (minutes)	< 5		
		5 - 10		
		10 - 20		
		20 - 30		
		≥ 30		
<b>26.</b>	Measures that are taken to correct the hypotension	Fluid		
		Vasopressor	Type	
			Dose	
		Both		